5.5 INDICATOR CONTAMINANTS IN TRANSITION ZONE WATER AND GROUNDWATER SEEPS

This section summarizes the Study Area data for TZW and groundwater seeps. As described in Section 3, the transition zone is defined as the interval where both groundwater and surface water comprise some percentage of the water occupying pore space in the sediments. The primary focus of the transition zone for this investigation is within the shallow sediment (0 to 38 cm bml), which includes the biologically active zone.[1] Deeper (>90 cm bml) TZW samples are also discussed here to lend insight into observed chemical distribution patterns.

The following subsections present tables, plan view maps with histograms, and scatter plots to support brief discussions of nature and extent for the select indicator contaminant list (Table 5.1-2). The full RI data sets for TZW and groundwater seeps for all sampled chemicals (those data of adequate quality) are presented in the RI SCRA database and summarized in Appendix D4, Tables D4-1 and D4-2.

Commented [A1]: Check and make sure that these are presented OK.

Commented [JMK2]: Since these are the base for Tables 5.5.1 and 5.5.2, the new text tables should only include the ICs while the appendix tables should include the remaining chemicals.

5.5.1 Transition Zone Water

The TZW sampling effort was not a harbor-wide study of TZW, but instead was a focused investigation offshore of nine study sites. Other areas of groundwater discharge to the river are not captured in this data set. Further, the sampling investigation of TZW did not seek to distinguish between areas impacted by upland sourced groundwater plumes or impacted by river sediments.[2] The approach to site selection is discussed in greater detail in Appendix C2.

The TZW investigations performed for the RI focused solely on areas of confirmed or likely groundwater plume discharge to the river and did not seek to characterize TZW pore water chemistry elsewhere in the Study Area. Accordingly, this discussion does not address TZW chemistry in areas with no upland groundwater discharge, or areas of clean groundwater flowing through contaminated sediments. Additionally, this study does not distinguish between the relative contribution of upland groundwater plumes and contaminants in sediment to the concentrations measured in TZW.

TZW data are presented on plan-view maps and/or scatter plots for select contaminants to support evaluation of sample composition. These presentations vary by analyte and the data are summarized in Table 5.5-1. As reflected in Table 5.5-1, the TZW analyte lists varied by study site; therefore, it was often unnecessary to produce maps for each river mile for a given analyte.

[1] The biologically active zone is defined by the depth of biological processes. The depth of the true biologically active zone varies widely throughout the Study Area, based on factors that control benthic community structure, such as sediment texture, sediment-water interface dynamics, and organic loading.

[2] In areas not directly affected by transport of contaminants originating in upland groundwater, contaminants may be present in TZW as a result of desorption from contaminated sediments and/or geochemical processes within the sediments and associated TZW.

Maps: Map presentations of TZW data use color-coded symbols and fly out labels to provide the individual concentration values. This presentation includes distinction of Peeper samples (0 to 38 cm bml), shallow TZW Trident samples (0 to 30 cm bml) and deeper Trident samples (90 to 150 cm bml), as well as non-LWG (0 to 90 cm bml) Geoprobe samples. Paired map sets are presented for each river mile to show filtered and unfiltered results, where available. Diffusion-based (peeper) samples are presented with a unique symbol on both filtered *and* unfiltered images to allow for a detailed evaluation of results. A histogram of detected contaminant concentrations is inset on each map to provide context for the results presented on the given river mile relative to the results from the entire Study Area. Histogram bins and concentration color ranges were selected based on professional judgment to best present the complete range of filtered and unfiltered concentration values observed across the Study Area. Maps 5.5-1 through 5.5-6 are provided for Total DDx, Total PAHs, arsenic, chromium, copper and zinc.

Scatter Plots: Scatter-plot presentations of TZW data show sample concentrations plotted according to the river mile of the sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each contaminant to show filtered and unfiltered results, where available. Peeper samples are presented with a unique symbol on both filtered *and* unfiltered images to allow for a detailed evaluation of results. Scatter plots are provided for Total DDx, Total PAHs, arsenic, chromium, copper and zinc as Figures 5.5-1a-f.

5.5.1.1 TZW Data Set

The TZW presentation provided in this section supports the detailed site-by-site presentation and analysis of groundwater pathways presented in Appendix C2. The Appendix C2 presentation of TZW provides data analysis focused on identification of complete groundwater pathways from upland plumes to the transition zone, including some cross-media analysis. This section focuses on presentation of the distribution of ICs observed in the transition zone. As such, this section does not discuss all contaminants from groundwater sources within the Study Area or relate observations to sources. The TZW chemistry data used in this investigation were generated during the following field events:

2004 Pilot Study – Integral 2006a

2005 Round 2 GWPA – Integral 2006d

2005 Siltronic Investigation – HAI 2005b; MFA 2005b

2007 Gasco Investigation – Anchor 2008b

These sampling activities focused on the offshore area of nine sites along the west bank of the river (see Map 2.1-20):

- Kinder Morgan Linnton Terminal (RM 4.1 to RM 4.2)
- ARCO Terminal 22T (RM 4.7 to RM 4.9)
- ExxonMobil Oil Terminal (RM 4.8 to RM 5.1)
- Gasco (RM 6.1 to RM 6.5)
- Siltronic (RM 6.3 to RM 6.5)
- Rhone Poulenc (RM 6.7 to RM 6.9)
- Arkema (Acid Plant and Chlorate Plant areas; RM 7.2 to RM 7.5)
- Willbridge Terminal (RM 7.6 to RM 7.8)
- Gunderson (RM 8.3 to RM 8.5)

Because TZW samples were collected at a single point in time (for Trident and Geoprobe sampling) or over a 3-week equilibration period (for peeper sampling), LWG field sampling events were carefully timed to maximize the expected upland groundwater signal (i.e., the time of greatest groundwater discharge rate). For the Pilot Study and Round 2 TZW investigations, TZW analytical samples were collected from November 2004 to January 2005 and October to December 2005, respectively, before river water levels increased to the higher levels that typically occur from mid-winter through spring. The non-LWG TZW samples collected at Gasco that are included in this nature and extent discussion were collected between July and September 2007. The non-LWG TZW samples collected at Siltronic that are discussed here were collected in May and June of 2005.

5.5.1.2 Total PCBs

TZW samples collected from the offshore areas of the nine sites were not analyzed for PCBs.

5.5.1.3 Total PCDD/Fs

Samples were collected using Trident sampling methodology from two locations adjacent to Rhone Poulenc for PCDD/Fs analyses, RP03C and RP07B. Sample RP03C was collected from a depth of 30 cm bml and analyzed for filtered and unfiltered PCDD/Fs, which were not detected above laboratory reporting limits. A parent and duplicate sample were collected from RP07B from a depth of 30 cm bml for filtered and unfiltered PCDD/F analyses. Total PCDD/Fs were detected in the parent and duplicate unfiltered samples, with concentrations of 29 pg/L and 51.3 pg/L, respectively. Total PCDD/Fs were detected in the parent filtered sample, with a concentration of 0.865 pg/L. Due to the limited set of data, the observed distribution of total PCDD/Fs inTZW could not be adequately described; scatter plots and distribution maps are not presented.

Commented [Integral3]: Select indicator contaminants analyzed in TZW are presented in the main text: PCDD/Fs, DDx, PAHs, arsenic, chromium, copper, and zinc. Other indicator contaminants will be presented in an appendix (text, maps, and figures parallel to those presented in the main text): HPAHs, LPAHs, cPAHs, BaPEq, benzo(a)pyrene, and naphthalene, TPH, diesel range hydrocarbons, and residual range hydrocarbons, cadmium, lead, nickel, and mercury. Other indicator contaminants (PCBs, BEHP, chlordanes, aldrin, dieldrin, TBT) were not analyzed in TZW samples.

Commented [Integral4]: Removed hyphens from sample IDs throughout for consistency with maps.

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5.5.1.4 TCDD TEQ

As described above, samples were collected using Trident sampling methodology from two locations adjacent to Rhone Poulenc for PCDD/Fs analysis, RP03C and RP07B. Total TEQs were calculated for the detected results in the parent and duplicate unfiltered samples collected from RP07B. The calculated concentrations were 1.72 J pg/L and 1.32 J pg/L, respectively. Due to the limited set of data, the observed distribution of TCDD TEQ inTZW could not be adequately described; scatter plots and distribution maps are not presented.

5.5.1.5 Total DDx

DDx was sampled offshore of the former Arkema Acid Plant and Rhone Poulenc sites. All but two of the sample locations were offshore of the Arkema Acid Plant site. As shown in Table 5.5-1, there are:

- 8 Peeper samples (0 to 38 cm bml), including two duplicates, collected offshore of the Arkema site;
- 18 shallow (0 to 30 cm bml) Trident samples, including four duplicates, collected offshore of the Arkema site and Rhone Poulenc (with eight collocated filtered and unfiltered samples); and
- 5 deep (90 to 150 cm bml) Trident samples (with collocated filtered and unfiltered samples collected at one location), including one location offshore of the Rhone Poulenc site.

DDx compounds were detected in two of the Peeper samples, with concentrations of 0.032 J ug/L at AP03B-1 and 0.0135 J ug/L at AP04D. DDx compounds were detected in each of the shallow Trident unfiltered samples with concentrations ranging from 0.0075 J ug/L at AP04D to 3.05 J ug/L at AP03A. DDx compounds were detected in all but three of the shallow Trident filtered samples with detected concentrations ranging from 0.0084 NJA ug/L at AP03B-1 to 0.158 NJ ug/L at RP03C. DDx compounds were detected in all three of the deep Trident unfiltered samples collected offshore of the Arkema site (0.169 J ug/L to 5.73 J ug/L) and the one offshore of Rhone Poulenc (0.17 J ug/L). DDx compounds were also detected in the unfiltered sample collected offshore of Rhone Poulenc (0.179 J ug/L).

Map 5.5-1 presents filtered (top panel) and unfiltered (bottom panel) total DDx (and constituent sums 2,4'- and 4,4'-DDD, 2,4'- and 4,4'-DDE, 2,4'- and 4,4'-DDT)[3] concentrations measured in shallow (0 to 30 cm bml) Trident and deep (90 to 150 cm bml) Trident samples. Peeper samples (0 to 38 cm bml) are presented with a unique symbol on both filtered *and* unfiltered images to allow for a detailed evaluation of results. Inset histograms on Map 5.5-1 show the distribution of total DDx sample

[3] Note that 2,4'-DDD, 2,4'-DDE, and 2,4'-DDT were not sampled during the 2004 Pilot Study; therefore, the total DDx sum for these samples consists of only the 4,4'-DDx isomers. These results are distinguished with an "A" descriptor on Map 5.4-1.

concentrations for detected filtered, unfiltered, and Peeper results. Scatter plots of filtered and unfiltered total DDx TZW concentrations from Trident and Peeper samples are provided on Figure 5.5-1a. All sample results for summed and individual DDx isomers in TZW are presented in the SCRA database and are summarized in Appendix D4, Table D4-1.

Commented [Integral6]: For consistency with the scatter plots, this sentence and the plot should include both Trident and Peeper samples.

Commented [KK7R6]: OK

Commented [Integral8]: A scatterplot for total DDx was not included in the Draft Final RI. A draft figure was provided to EPA on 7/18/2013.

Commented [KK9R8]: Agreed – see matrix.

5.5.1.6 Total PAHs

PAHs were sampled at six of the nine TZW study sites: Kinder Morgan, ARCO, ExxonMobil, Gasco, Siltronic, and Willbridge Terminal. The discussion below focuses on Total PAH results, which are summarized in Table 5.5-1. HPAHs, LPAHs, cPAHs, BaPEq, as well as individual PAH results, are presented in Appendix D4, Table D4-1.

Total PAH data include the following samples:

- 24 Peeper samples (0 to 38 cm bml), including 6 duplicates;
- 81 shallow (0 to 30 cm bml) Trident samples, including 15 duplicates, collected from 35 locations (with collocated filtered and unfiltered samples collected at 31 locations);
- 14 deep (90 to 150 cm bml) Trident samples in this data set (with collocated filtered and unfiltered samples collected at 4 locations); and duplicate samples collected at 2 locations.
- 35 unfiltered samples collected with a Geoprobe from depths of 0 to 90 cm bml.

PAHs were detected in TZW samples offshore of all six sites. Total PAHs were identified in all of the Peeper samples, with concentrations ranging from 0.105 J ug/L at KM10A, offshore of Kinder Morgan, to 300 J ug/L at GS01B, offshore of Gasco. Total PAHs were detected in all but 3 of the shallow Trident unfiltered samples with concentrations ranging from 0.0025 J ug/L at EM02A, offshore of ExxonMobil, to 3,490 ug/L at GS07B, offshore of Gasco. Total PAHs were identified in all but two of the shallow Trident filtered samples with detected concentrations ranging from 0.0031 J ug/L at W09A to 1,200 J ug/L at GS02A, which are offshore of Willbridge Terminal and Gasco, respectively.

Commented [Integral10]: Request that the more specific term "detected" be used throughout the text, rather than "identified".

Commented [KK11R10]: Agreed.

For the deep Trident samples, total PAHs were detected in all seven unfiltered samples, with the minimum concentration of 0.61 J ug/L measured offshore of ARCO at R2AR02, and the maximum concentration of 430 ug/L measured offshore of Gasco at GS08D. Total PAHs were detected in all 4 deep Trident filtered samples, with concentrations ranging from 0.182 ug/L to 15.8 ug/L. The minimum filtered concentration was collocated with the minimum deep unfiltered measurement, at R2AR02. The maximum filtered deep concentration was measured at EM03A, offshore of ExxonMobil. Total PAHs were detected in all 35 Geoprobe samples collected from 0 to 90 cm bml, with a minimum concentration of 0.093 ug/L measured at GS-D3

offshore of Gasco, and a maximum concentration of 15,100 ug/L measured at GP73 offshore of the Gasco/Siltronic property boundary.

The Total PAH sample results are presented on Maps 5.5-2a–e. The map set presents filtered (top panel) and unfiltered (bottom panel) TZW results, where available, with inset histograms summarizing the distribution of samples shown on each map relative to the distribution across the TZW data set. Sample results collected between RM 6 and 7 are presented on two maps to allow for presentation of all sample concentration results in this densely sampled area (the first map shows concentration labels for LWG-collected data, and the second map shows concentration labels for non-LWG collected data). Observed PAH concentration ranges varied among the offshore study areas, with the highest total PAH concentrations consistently being observed offshore of the Gasco and Siltronic sites. The lowest range of TZW PAH concentrations was observed offshore of the Willbridge Terminal site. These relative concentration ranges are apparent on the inset histograms on Maps 5.5-2a–e.

Scatter plots of filtered and unfiltered total PAH TZW concentrations from Trident, Peeper, and Geoprobe samples are provided on Figure 5.5-1b. These figures show sample concentrations along an x-axis noting the river mile of each sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each chemical to show filtered and unfiltered results, where available.

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5.5.1.7 BEHP

TZW samples collected from the offshore areas of the nine study sites were not analyzed for BEHP.

5.5.1.8 Total Chlordanes

TZW samples collected from the offshore areas of the nine study were not analyzed for chlordanes.

5.5.1.9 Aldrin

TZW samples collected from the offshore areas of the nine study sites were not analyzed for aldrin.

5.5.1.10 Dieldrin

TZW samples collected from the offshore areas of the nine study sites were not analyzed for dieldrin.

5.5.1.11 Arsenic

TZW samples were analyzed for arsenic at all nine TZW study sites. Sampling results for arsenic are presented on scatter plots in Figure 5.5-1c. This figure shows sample concentrations along an x-axis noting the river mile of each sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each chemical to show filtered and unfiltered results, where available. Additionally,

Commented [Integral14]: A draft figure was provided to EPA on 7/18/2013.

arsenic results are presented on Maps 5.5-3a–e. The map set presents filtered (top panel) and unfiltered (bottom panel) TZW results, where available, with inset histograms summarizing the distribution of samples shown on each map relative to the distribution across the TZW data set.

As shown in Table 5.5-1, arsenic data collected for TZW include results from the following samples:

- 39 Peeper samples (0 to 38 cm bml), including 10 duplicates;
- 60 shallow (0 to 30 cm bml) filtered Trident samples, including 11 duplicates;
- 64 shallow (0 to 30 cm bml) unfiltered Trident samples, including 11 duplicates;
- 24 unfiltered and 12 filtered deep (90 to 150 cm bml) Trident samples, including 5 duplicates;
- 35 unfiltered and 4 filtered samples collected with a Geoprobe from depths of 0 to 90 cm bml.

Arsenic was detected in TZW samples offshore of all nine sites. Arsenic was detected in all but two of the Peeper samples, with concentrations ranging from 0.3 J ug/L (locations ARC03B, ARC06B-1, and ARC06B-2) to 17.2 ug/L at W04C. The maximum detected concentration was identified offshore of the Willbridge Terminal site. Arsenic was detected in 55 of the shallow Trident filtered samples, with detected concentrations ranging from 0.55 ug/L at W09A, offshore of Willbridge Terminal, to 76.8 ug/L at EM03A, offshore of ExxonMobil. Arsenic was detected in all but 3 of the shallow Trident unfiltered samples with concentrations ranging from 0.72 ug/L at CP08B to 51.2 ug/L at W12A, which are offshore of Arkema and Willbridge Terminal, respectively.

For the unfiltered deep Trident samples, total arsenic was detected in all but one sample. The minimum detected concentration of 1.36 J ug/L was measured offshore of Gunderson at GN05A, and the maximum concentration of 77.1 ug/L was measured offshore of ExxonMobil at EM03A. Dissolved arsenic was detected in all 12 filtered deep Trident samples, with concentrations ranging from 0.98 ug/L to 77.3 ug/L. The minimum and maximum filtered concentrations were collocated with the minimum and maximum unfiltered concentrations, at stations GN05A and EM03A, respectively. Arsenic was detected in 22 of the 35 unfiltered Geoprobe samples, with the minimum detected concentration of 0.77 ug/L measured at GS-C3, and the maximum concentration of 65.4 J ug/L measured at GS-D3, both offshore of Gasco. Dissolved arsenic concentrations in the four filtered Geoprobe samples ranged from 0.94 ug/L to 5.52 ug/L, measured offshore of Gasco at stations GS-B1 and GS-B5, respectively.

5.5.1.12 Chromium

Samples collected at all nine TZW study sites were analyzed for chromium. Analytical results for chromium are presented on scatter plots in Figure 5.5-1d. These figures show sample concentrations along an x-axis noting the river mile of each sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each chemical to show filtered and unfiltered results, where available. Additionally, chromium results are presented on Maps 5.5-4a–e. The map set presents filtered (top panel) and unfiltered (bottom panel) TZW results, where available, with inset histograms summarizing the distribution of samples shown on each map relative to the distribution across the TZW data set.

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As shown in Table 5.5-1, chromium data collected within the Study Area offshore of the nine sites referenced above include results from the following samples:

- 39 Peeper samples (0 to 38 cm bml), including 10 duplicates;
- 62 shallow (0 to 30 cm bml) filtered Trident samples, including 11 duplicates;
- 65 shallow (0 to 30 cm bml) unfiltered Trident samples, including 11 duplicates;
- 25 unfiltered and 13 filtered deep (60 to 150 cm bml) Trident samples , including 3 unfiltered and 2 filtered duplicates; and
- 35 unfiltered and 4 filtered samples collected with a Geoprobe from depths of 0 to 90 cm bml.

Chromium was detected in TZW samples collected from locations offshore of all nine sites. Chromium was detected in 17 of the Peeper samples, with concentrations ranging from 0.92 ug/L at location CP09D to 31.6 ug/L at CP07B, both of which were identified offshore of the Arkema site. Chromium was detected in 34 of the shallow Trident filtered samples, with detected concentrations ranging from 0.2 J ug/L at W09A, offshore of Willbridge Terminal, to 98.3 ug/L at CP07B, offshore of Arkema. Chromium was detected in 45 of the shallow Trident unfiltered samples with concentrations ranging from 0.79 ug/L at SL03A to 122 ug/L at CP07B, which are offshore of Siltronic and Arkema, respectively.

For the unfiltered deep Trident samples, total chromium was detected 20 samples. The minimum detected concentration of 0.8 ug/L was measured adjacent to Rhone Poulenc at RP02E, and the maximum concentration of 102 ug/L was measured offshore of the Arkema site at CP07B. Dissolved chromium was detected in 7 filtered deep Trident samples, with concentrations ranging from 0.36 ug/L at EM01A, offshore of ExxonMobil, to 49.6 ug/L at CP07B. Chromium was detected in all of the 35 unfiltered Geoprobe samples, with the minimum detected concentration of 2.07 ug/L measured at GS-D2 offshore of Gasco, and the maximum concentration of 537 ug/L measured at GS-B9 offshore of Siltronic. Dissolved chromium concentrations in the three detected

filtered Geoprobe samples ranged from 0.45 ug/L to 0.69 ug/L, measured offshore of Gasco at stations GS-B4 and GS-B5, respectively.

5.5.1.12 Copper

Samples collected at all nine TZW study sites and non-LWG Gasco and Siltronic field events were analyzed for copper. Analytical results for copper are presented on scatter plots in Figures 5.5-1e. These figures show sample concentrations along an x-axis noting the river mile of each sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each chemical to show filtered and unfiltered results, where available. Additionally, copper results are presented on Maps 5.5-5a–e. The map set presents filtered (top panel) and unfiltered (bottom panel) TZW results, where available, with inset histograms summarizing the distribution of samples shown on each map relative to the distribution across the TZW data set.

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As shown in Table 5.5-1, copper data collected within the Study Area offshore of the nine sites referenced above include results from the following samples:

- 39 Peeper samples (0 to 38 cm bml), including 10 duplicates;
- 50 shallow (0 to 30 cm bml) filtered Trident samples, including 9 duplicates;
- 53 shallow (0 to 30 cm bml) unfiltered Trident samples, including 9 duplicates;
- 18 unfiltered and 12 filtered deep (90 to 150 cm bml) Trident samples including 3 unfiltered and 2 filtered duplicates; and
- 35 unfiltered and 4 filtered samples collected with a Geoprobe from depths of 0 to 90 cm bml.

Copper was detected in TZW samples collected from locations offshore of all nine sites. Copper was detected in 5 Peeper samples, with concentrations ranging from 1.63 ug/L at location ARC02B to 22.1 ug/L at CP07D. The maximum detected concentration was identified offshore of the Arkema site. The remaining four detected copper concentrations were identified in samples collected from locations offshore of ARCO.

Copper was detected in 10 of the shallow Trident filtered samples, with detected concentrations ranging from 0.36 ug/L at R2KM01 to 3.63 ug/L at R2RP03, which are offshore of Kinder Morgan and Rhone Poulenc, respectively. Copper was detected in 35 of the shallow Trident unfiltered samples with concentrations ranging from 1.54 ug/L at ARC02B to 63.1 ug/L at EM02C, which are offshore of ARCO and ExxonMobil, respectively.

For the unfiltered deep Trident samples, total copper was detected 13 samples. The minimum detected concentration of 1.79 ug/L was measured adjacent to Rhone Poulenc at RP02E, and the maximum concentration of 43.7 ug/L was measured offshore of the

Siltronic site at SL03F. Dissolved copper was detected in 7 filtered deep Trident samples, with concentrations ranging from 0.24 ug/L at GN05A, offshore of Gunderson, to 1.89 J ug/L at R2AR02, offshore of ARCO. Copper was detected in 29 of the unfiltered Geoprobe samples, with the minimum detected concentration of 1.01 J ug/L measured at GS-C6, offshore of Gasco, and the maximum concentration of 555 ug/L measured at GS-B9, offshore of Siltronic. Dissolved copper concentrations were detected in all four filtered Geoprobe samples; concentrations ranged from 0.28 ug/L at locations GS-B4 and GS-B5 to 0.79 ug/L at GS-B2, all measured offshore of Gasco.

5.5.1.12 Zinc

Samples collected from all nine TZW study sites and non-LWG Gasco and Siltronic field events were analyzed for zinc. Analytical results for zinc are presented on scatter plots in Figures 5.5-1f. These figures show sample concentrations along an x-axis noting the river mile of each sample location. Color-coded symbols distinguish sample type and depth. Paired plot sets are presented for each chemical to show filtered and unfiltered results, where available. Additionally, zinc results are presented on Maps 5.5-6a–e. The map set presents filtered (top panel) and unfiltered (bottom panel) TZW results, where available, with inset histograms summarizing the distribution of samples shown on each map relative to the distribution across the TZW data set.

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As shown in Table 5.5-1, zinc data collected within the Study Area offshore of the nine sites referenced above include results from the following samples:

- 39 Peeper samples (0 to 38 cm bml), including 10 duplicates;
- 60 shallow (0 to 30 cm bml) filtered Trident samples, including 11 duplicates;
- 64 shallow (0 to 30 cm bml) unfiltered Trident samples, including 11 duplicates;
- 24 unfiltered and 12 filtered deep (60 to 150 cm bml) Trident samples including 3 unfiltered and 2 filtered duplicate samples; and
- 35 unfiltered and 4 filtered samples collected with a Geoprobe from depths of 0 to 90 cm bml.

Zinc was detected in TZW samples collected from locations offshore of all nine sites. Zinc was detected in 18 Peeper samples, with concentrations ranging from 7.11 J ug/L at location R2KM02, which is offshore of Kinder Morgan, to 418 ug/L at R2CP01. The maximum detected concentration was identified offshore of the Arkema site.

Zinc was detected in 32 of the shallow Trident filtered samples, with detected concentrations ranging from 0.95 ug/L at R2KM01 to 526 ug/L at R2AR01, which are offshore of Kinder Morgan and ARCO, respectively. Zinc was detected in 39 of the shallow Trident unfiltered samples with concentrations ranging from 7.81 J ug/L at

W09A to 556 ug/L at R2AR01, which are offshore of Willbridge Terminal and ARCO, respectively.

For the unfiltered deep Trident samples, total zinc was detected 17 samples. The minimum detected concentration of 18.6 J ug/L was measured at AP03D offshore of Arkema Acid Plant area, and the maximum concentration of 161 ug/L was measured at CP07B offshore of the Arkema Chlorate Plant area. Dissolved zinc was detected in 7 filtered deep Trident samples, with concentrations ranging from 1.87 J ug/L at AR01A to 9.78 ug/L at R2AR02, both offshore of ARCO. Zinc was detected in all but one of the 35 unfiltered Geoprobe samples, with the minimum detected concentration of 8.3 ug/L measured at GS-C6 and the maximum concentration of 3,590 ug/L measured at GS-B4, both offshore of Gasco. Dissolved zinc concentrations in the filtered Geoprobe samples ranged from 2.93 ug/L to 22.5 ug/L, measured offshore of Gasco at stations GS-B2 and GS-B5, respectively.

5.5.1.12 TBT

TZW samples collected from the offshore areas of the nine study sites were not analyzed for TBT.

5.5.2 Groundwater Seeps

This section summarizes the location, available chemical data, and data quality assessment for upland groundwater seeps. The groundwater seep data set is limited because a comprehensive seep characterization was not part of the Portland Harbor RI program. Consequently, the data set does not lend itself to the same contaminant distribution discussions applied to TZW and other media in this report (specifically, discussion of select analytes).

5.5.2.1 Groundwater Seep Locations

A seep reconnaissance survey was conducted during Round 1 of the Portland Harbor RI/FS (GSI 2003b) to support the BHHRA and development of the CSM. This survey documented readily identifiable groundwater seeps based on visual observations along approximately 17 miles of riverbank from RM 2 to 10.5. For the purposes of this survey, a seep was defined as groundwater discharge above the Willamette River water line as observed during the seep reconnaissance survey. This groundwater may be discharged from local shallow groundwater systems, perched groundwater, water seeping through utility backfill, or return flow from tidally influenced bank storage. Observed seeps were classified into one or more of five types:

- Seepage line at the base of embankments (nine seeps)
- Linear and point seeps at the foot of beaches (six seeps)
- Seepage through backfill surrounding outfalls (four seeps)
- Seepage of NAPL (two seeps)

- Potential seep locations identified by observation of extensive ferric hydroxide staining of bank materials (eight potential seeps).

Additionally, eight seeps were categorized as combinations of the above seep types.

5.5.2.2 Groundwater Seep Water Quality Data

Seep water quality samples have been collected at six seeps in four general areas (Map 5.4-7). The water quality sampling efforts conducted for upland groundwater seeps include:

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- City of Portland stormwater Outfalls 22B and 22C, located directly north and south of the Railroad Bridge at RM 6.89 and 6.82, respectively, are type 3 (backfill surrounding outfalls) seeps. Both Rhone Poulenc and NW Natural have collected water quality samples in Outfalls 22B and 22C to evaluate potential groundwater infiltration to the conveyance systems. These results are described in the next two bullets in this list.
- Rhone Poulenc sampled Outfall 22B on five occasions between October 1, 1993 and September 23, 2004 and Outfall 22C four times between August 13, 2002 and September 23, 2004. Samples were collected at the end of the pipe and were analyzed for 231 individual parameters, including conventionals, PCDD/Fs, herbicides, metals, PAHs, PCB Aroclors, pesticides, petroleum hydrocarbons, phenols, phthalates, SVOCs, and VOCs. The results are Category 1 data validated to the QA2 level, with the exception of petroleum hydrocarbon results measured on September 23, 2004, which are Category 2 data and will be excluded from this discussion.
- NW Natural sampled Outfall 22C on February 24, 2005 for 89 individual parameters, including conventionals, metals, PAHs, phenols, phthalates, SVOCs, and VOCs. Data were validated to Category 2, QA1 level.
- Seeps-01, -02, and -03 are located at the Gunderson site near RM 8.5. These type 3 seeps are associated with cracked stormwater drain pipes. Each seep was sampled once in November 2004 and again in April 2005, with samples analyzed for 31 individual parameters, including conventionals, metals, PCB Aroclors, PAHs, petroleum hydrocarbons, SVOCs, VOCs, and phthalates. Data were validated to Category 1, QA1.
- ExxonMobil sampled areas with visible sheen on sand and in pooled water along the riverbank at the ExxonMobil site under the direction of DEQ on August 13, 2004 (Kleinfelder 2004) and October 6, 2003. Two composite samples were analyzed as soils for DRH, GRH, and RRH. Data were validated to the QA1 level. All results were below instrument detection limits.

A summary of the indicator contaminant data collected at each of the above mentioned locations is provided in Table 5.5-2. All of the seep data collected from these locations is presented in Appendix D4 (Table D4-2).

Commented [Integral20]: Per EPA edit, need to develop table of indicator contaminant data collected at all seep locations. Table will be drafted.

Commented [JMK21]: This appendix table needs to provide all of the seep data, not just the data associated with locations evaluated in the HHRA.

Commented [Integral22]: Per EPA edit, appendix table will be updated to include all seep data.

Commented [Integral23]: Per meeting with EPA on 7/8/14, data for all seeps will be presented in the main text summary table 5.5-2 and the Appendix D4 summary stats tables. Text discussions of seeps results were removed. Seeps data are extremely limited and seeps were never sampled comprehensively/systematically across the Study Area. The seeps data has been used in determination of potential complete groundwater pathways from upland to the river, as well as in the human health risk assessment. The data are not adequate to support a chemical distribution discussion such as presented in Section 5 for other mediadoes not lend itself to the general organization of the contaminant distribution discussions applied.